



Backgrounder: Intel® Centrino™ Mobile Technology

On March 12, 2003, Intel will announce Intel® Centrino™ mobile technology. Intel Centrino mobile technology with integrated wireless LAN capabilities is designed specifically for wireless notebook PCs – delivering breakthrough mobile performance and enabling extended battery life in thinner, lighter notebook PCs.* Intel Centrino mobile technology is comprised of three silicon components including: Intel® Pentium® M processor family, Intel® 855 chipset family and Intel® PRO/Wireless 2100 network connections delivering Intel-tested and -tuned reliability and compatibility.

Intel Centrino mobile technology is optimized, tested and validated for mobility, supporting a wide range of industry wireless LAN security standards and leading third party solutions now and in the future. To support wireless connectivity, Intel has developed a Wireless Verification Program to test Intel Centrino mobile technology with leading access point products and verifying interoperability with a variety of WLAN enabled locations. Intel is working with leading public access point providers around the world to enhance Intel Centrino mobile technology compatibility.

Intel Pentium M processor family is the next generation mobile processor architecture for mobile PCs, available with speeds up to 1.60GHz. Three product families will be announced including the Ultra-Low Voltage processors for sub-notebooks and tablet PCs, Low Voltage processors for mini-notebook PCs and Standard Voltage processors for mainstream notebooks. Key high performance and low power features include a new Intel Pentium M processor Micro-Architecture consisting of Micro-Ops Fusion, Advanced Instruction Prediction, Dedicated Stack Manager, Power-Optimized 400 MHz processor system bus, Larger Power-Aware 1MB L2 Cache and Intelligent Power Distribution. Microprocessors are offered in both Micro-FCBGA and Micro-FCPGA packages. All of these technologies make outstanding performance possible for mobile PCs in a variety of shapes and sizes.

Intel Pentium M processor achieves high performance by using Micro-Ops Fusion to merge CPU operations together prior to execution in order to increase performance and efficiency. It uses Advanced Instruction Prediction to analyze a program's past behavior to predict which operations are likely to be requested in the future. It also has a Dedicated Stack Manager, which significantly reduces the number of micro-operations required for the "overhead" of stack management inside the processor. A stack manager on a traditional processor repeatedly interrupts program execution to maintain its own internal accounting. Finally, Intel Pentium M processor micro-architecture has a Power-Optimized 400MHz Processor System Bus, which remains powered down until it senses incoming data from the chipset. This allows to the processor to consume less power.

The power-aware 1MB integrated L2 cache runs at full speed and is designed to help improve performance and extend battery life. It complements the system bus by providing critical data faster and reducing total system power consumption. The processor, when used in conjunction with Microsoft® Windows™* XP operating system or the Intel® SpeedStep™ technology applet, supports Enhanced IntelSpeedStep™ technology with Multiple Voltage / Frequency Operating Points, which enables real-time dynamic switching of the voltage and frequency between multiple performance modes based on CPU demand. This occurs by switching the bus ratios, core operating voltage, and core processor speeds without resetting the system. The processor also features the ultra low power alert state called Deeper Sleep, which enables the processor to retain critical data at very low voltages and minimizes power dissipation when the processor is not active.

The Intel® 855 chipset family offers higher performance, and flexible and scalable platforms for both discrete graphics (855PM) and integrated graphics (855GM) platforms. The Intel® 855 chipset family has support for up to 2GB of DDR 266/200 memory. The dynamic input/output buffer disables the processor system bus and memory by activating and/or powering-down the processor and/or memory as needed for lower platform (cpu, chipset, memory) power consumption. Intel® Stable Image Technology is a new capability built into the chipset and enabled in the BIOS. This new silicon technology provides greater IT software image stability by enabling simple chipset hardware changes without triggering the "new hardware found" message—eliminating automatic and unnecessary re-qualification. The I/O controller supports USB 2.0 peripherals for 40X faster data transfer rate and backward compatible to support USB 1.0 devices.

The Intel® 855GM chipset has several unique integrated graphics chipset enhancements. The Intel 855GM has optimized internal clocking to lower chipset power by clocking 3D and display engines only when needed. Intel855GM also has Intel Extreme Graphics 2 to deliver intense, realistic 3D graphics with sharp images and enables balanced memory usage between graphics and system for optimal performance. The Intel 855GM chipset with Intel Extreme Graphics 2 also provides enhanced 3D graphics performance over the previous generation Intel® 830M chipset. Additionally, the Intel 855GM supports unified graphics driver, which reduces total cost of ownership (TCO) by converging to one driver for mobile and desktop clients. Finally, Intel855GM chipset has integrated low voltage differential signal (LVDS) interface providing higher integration, which consumes less motherboard space, allowing smaller notebook designs.

Intel® PRO/Wireless 2100 network connection offers single band support providing the ability to connect to 802.11b Wi-Fi networks at launch. Shortly after launch, Intel plans to launch dual band support for 802.11a/b Wi-Fi networks. At launch, IntelPRO/Wireless 2100 network supports industry standard and extended wireless security support (LEAP, 802.1x, WEP), which enables enhanced wireless LAN networking security in compliance with evolving industry standards. Shortly after launch, Intel will be updating software drivers to support WPA, Cisco compatibility (CCX), TKIP, CKIP.

Three major enhancements have been made to the Intel PROSet software including: 1) Advanced Profile Management Support allows setup of an unlimited number of profiles to connect to different WLAN networks; 2) Automatic WLAN Switching Support enables automatic switching between wired and wireless LAN, will also manage VPN connections; and 3) Ad Hoc Connection Wizard Support provides a simplified interface for setting up ad hoc networks. Intel® Wireless Coexistence System support enables reduced interference between IntelPRO/Wireless and certain Bluetooth™* devices. Power Save Protocol (PSP) has five different power settings allowing users to trade off performance versus battery life. Intel® Intelligent Scanning Technology reduces power by controlling the frequency of scanning for access points. Antenna diversity provides real-time antenna selection to optimize WLAN performance.

The new Intel Centrino mobile technology offers a generational leap in performance and low power capabilities for enhanced mobility and connectivity in a stable and scalable platform. The Pentium M processor is designed and tuned to work with the Intel 855 chipsets and Intel PRO/Wireless 2100 network connections. Intel Centrino mobile technology with integrated wireless LAN capabilities is designed specifically for wireless notebook PCs – delivering breakthrough mobile performance and enabling extended battery life in thinner, lighter notebook PCs.*

Intel® Centrino™ Mobile Technology Product Features

Intel® Pentium® M Processor

Micro-Ops Fusion

Micro-Ops Fusion is a technology that uses fewer CPU resources to execute operations than traditional microprocessors by merging CPU operations together prior to execution in order to increase performance and efficiency. When the micro-operations are fused they use less processor resources in order to handle the same number of operations. Two fused micro-operations occupy a single resource and thus they make the machine behave as a wider machine. Micro-ops fusion delivers efficiency in both performance and power management.

Advanced Instruction Prediction

The Intel Pentium M processor also uses advanced instruction prediction, a technology that allows the processor to study the past behavior of programs and intelligently anticipate what instructions will be needed next. The processor can line up instructions for execution before a program requests them. By anticipating changes in program flow rather than merely responding to them, the processor improves performance and efficiency. Predicting branches correctly is one of the areas of high leverage for both performance and power. On top of the standard Bi-Model/Global predictor Intel Pentium M processor also includes a loop detector and an indirect branch target buffer. Intel Pentium M processor employs the best in class branch prediction mechanism.

Dedicated Stack Manager

The Intel Pentium M processor has a Dedicated Stack Manager, which significantly reduces the number of micro-operations required for the “overhead” of stack management inside the processor. Traditional processors repeatedly interrupt program execution to maintain their own internal accounting. Intel Pentium M processor uses sophisticated, specialized-hardware enabling the processor to execute program instructions without interruption, using less power.

Certain instructions use the architectural stack as source of operands. In those instructions there's an overhead work of managing the stack on top of the actual operation that needs to occur. Typically those overhead operations are done using the main machine flow which is a very inefficient way from both power and performance perspective. There are advanced synchronization mechanisms that make sure that the stack pointer value is visible to the software just when it's needed.

Power-Optimized 400 MHz Processor System Bus

Finally, Intel Pentium M processor micro-architecture has a Power-Optimized 400MHz Processor System Bus, which remains powered down until it senses incoming data from the chipset, allowing to the processor to consume less power. In a typical microarchitecture, a processor has its bus turned on even when it is not in use. With the Intel Pentium M processor, portions of the bus are turned on only when they are needed. Architectural and circuit innovations enabled this power-optimized processor system bus technology which lowers power through reduced voltage swing and tighter buffer management.

Intelligent Power Distribution

Most machines employ some level of hardware clock gating to reduce power consumption. Intel Pentium M processor implements finer granularity hardware gating mechanisms that allows turning on hardware units partially based on program demand.

Large, Power-Aware 1MB Secondary Cache

The processor also includes a 1MB secondary cache. The large cache allows a significant reduction in memory data latency providing a big performance improvement. The power-aware cache implements several features to reduce cache power consumption. Traditional microprocessors run the cache as fast as possible, the processor cache on the Intel Pentium M processor runs slightly slower to save energy and cut down on electricity leakage enabling longer battery life. Special circuit and micro-architectural innovations were implemented in order to reduce power consumption.

Deeper Sleep Alert State

Deep Sleep and Deeper Sleep Alert States are very low power states the processor can enter during periods of inactivity while still maintaining its context. The Deeper Sleep Alert State is functionally identical to the Deep Sleep Alert State but at a significantly lower voltage providing added benefits of power savings and longer battery life. The Deeper Sleep Alert State is automatically enabled on the platform through the I/O Controller Hub component and the voltage regulator, so there is no user interaction required. This feature maintains processor performance characteristics while taking advantage of the increased power savings.

Enhanced Intel® SpeedStep™ Technology with Multiple Voltage/Frequency Operating Points

Mobile Intel Pentium 4 Processor-M supports Enhanced Intel SpeedStep technology allowing the processor to switch between only two core performance frequencies.

Intel Pentium M processors add new capabilities to Enhanced Intel SpeedStep technology with multiple voltage / frequency operating points. This means that dynamic transitions will happen at smaller intervals between the Battery-Optimized mode (lowest voltage / frequency) and the Performance-Optimized mode (highest voltage / frequency), enabling higher performance and lower power for each workload. With dynamic switching capability mobile systems can switch between the multiple operating points based on CPU utilization, without user intervention. The result is that the user observes higher performance and extended battery-life automatically. Enhanced Intel SpeedStep technology with multiple voltage/frequency operating points enables optimum performance at the lowest power whether connected to AC or Battery Power, resulting in a better user experience with no battery life degradation.

Latest Packaging Technology

Flip-chip packaging eliminated the wire-bond approach in favor of mounting the die directly to a substrate, improving power delivery and reducing impedance. The mobile Micro-FCPGA (micro flip chip pin grid array) and Micro-FCBGA (micro flip chip ball grid array) packaging technology provides significant improvements in power delivery and pin inductance compared to their predecessors resulting in dramatically improved performance. The packages incorporate separate power and ground planes and on-package capacitance needed at higher speeds – reducing board space for the implementation. Space savings contribute to smaller designs and more mobility.

0.13 micron Process Technology

Microprocessors designed on the 0.13 micron technology enable Intel to design processors with the highest levels of performance, the lowest power consumption and at lower cost for all mobile PC segments. Intel's 0.13 micron technology features the world's fastest transistors; the smallest transistor gate; the thinnest gate oxide and the smallest SRAM cell in volume production today. These features combined deliver the highest performance and lowest power consumption across all Mobile PC segments. The 0.13 micron technology means that the size of lines (or spaces on the chip) is 0.13 microns. This higher density of transistors enables more computing power (i.e. Performance) and more features (i.e. Capabilities) to be packed within the same space, or less, giving you more functionality for your PC. More transistors equates to more computing power plus added functionality.

Streaming SIMD Extensions 2 (SSE2)

Intel Pentium M processor micro-architecture includes the new extensions to SIMD capabilities that MMX technology and SSE technology delivered by adding 144 new instructions. These instructions include 128-bit SIMD integer arithmetic and 128-bit SIMD double-precision floating-point operations. These new instructions reduce the overall number of instructions required to execute a particular program task and as a result can contribute to an overall performance increase. They accelerate a broad range of applications, including video, speech, and image, photo processing, encryption, financial, engineering and scientific applications.

Intel® 855 Chipset Family

Dynamic Input/Output Buffer Disabling for PSB and Memory

The processor system bus and/or memory have dynamic activation and/or power-down as needed for lower platform (cpu, chipset, memory) power consumption.

Flexible Support for High Performance Discrete Graphics Solutions (855PM)

The Intel® 855PM chipset has a AGP 4X interface and provides flexible support for high performance discrete graphics solutions.

Optimized Internal Clock Gating for 3D and Display Engines (855GM)

The Intel® 855GM chipset lowers chipset power by clocking 3D and display engines only when needed.

Optional 855GM with Intel® Extreme Graphics 2 technology

The optional integrated graphics solution 855GM delivers intense, realistic 3D graphics with sharp images and enables balanced memory usage between graphics and system for optimal performance. The Intel 855GM chipset with Intel Extreme Graphics 2 also provides enhanced 3D graphics performance over the previous generation Intel® 830M chipset. Enhanced graphics performance is achieved by operating 855GM at a higher graphics core frequency (200MHz), supporting higher speed DDR memory technology and supporting the 400MHz Intel® Pentium M processor system bus.

Integrated low voltage differential signal (LVDS) interface (855GM)

The 855GM chipset has an integrated LVDS interface that enables the notebook display panel to connect directly to the chipset and eliminates the need for a video controller hub component. The result is higher integration for savings in mother board space and reduced BOM cost for OEMs.

Intel® Stable Image Technology Support

IntelStable Image Technology is a new capability built into the chipset and enabled in the BIOS. This new silicon technology provides greater IT software image stability by enabling simple chipset hardware changes without triggering the "new hardware found" message—eliminating automatic and unnecessary re-qualification.

DDR Memory 266 / 200MHz

The Intel 855 chipsets supports DDR memory at 266 and 200 MHz. DDR memory technology increases memory bandwidth up to 2.1GB/sec (2x faster than PC133 SDRAM at 1GB/sec) for accelerating applications using Intel Pentium M processor micro-architecture.

Up to 2GB DDR Memory Support

The Intel 855 chipset family supports up to 2GB of system memory, which enables less page swapping from disk and quicker access to data and applications.

I/O Controller Hub Architecture with USB 2.0 Support

The I/O Controller Hub architecture doubles the I/O bandwidth along with dedicated support for 40X faster peripherals with USB 2.0 support, enabling smoother multimedia performance.

Integrated 10/100 LAN, Enhanced 20-bit Audio, and AC97 Modem (56kbps) Interface

The I/O controller hub supports enhanced 20-bit audio support to enable higher audio quality over traditional 16-bit audio. This highly integrated chipset supports the latest connectivity and digital audio technology to reduce platform costs.

ACPI 2.0 and APM 1.2 system power management

This chipset delivers system power savings based on the latest ACPI implementations as well as legacy APM system power management designs.

Mobile Clock Manager

The mobile clock manager controls the chipset's clock speed to reduce chipset power during periods of low activity for extending battery life.

PCI Moon2 Docking Support

This chipset is designed to support Intel's PCI Moon2 docking solution for desktop level interface with peripherals such as VGA monitors, mouse, audio speakers, PDAs, and other peripherals.

Intel® PRO/Wireless 2100 Network Connection

Single and Dual Band Support

At launch, Intel PRO/Wireless 2100 network connection offers single band support providing the ability to connect to 802.11b Wi-Fi networks. Shortly after launch, Intel plans to launch dual band support for 802.11a/b Wi-Fi networks.

Supporting Industry Standard and Extended Wireless Security Support (LEAP, 802.1x, WEP)

At launch, Intel PRO/Wireless 2100 network supports industry standard and extended wireless security support (LEAP, 802.1x, WEP), which enables enhanced wireless LAN networking security in compliance with evolving industry standards.

Intel® PROSet Software Support

- **Intel PROSet with advanced profile management support**
Allows setup of an unlimited number of profiles to connect to different WLAN networks.
- **Intel PROSet with automatic WLAN switching support**
Enables automatic switching between wired & wireless LAN, will also manage VPN connections.
- **Intel PROSet with ad hoc connection wizard support**
Provides a simplified interface for setting up ad hoc networks.

Intel® Wireless Coexistence System Support

Support for the coexistence system enables reduced interference between Intel PRO/Wireless and certain Bluetooth™* devices.

Power Save Protocol (PSP)

A user-selectable feature with 5 different power states allows the user to make their own power versus performance choice when in battery mode.

Intel® Intelligent Scanning Technology

This feature gradually increases the period of the scan frequency of the Intel PRO/Wireless 2100 network connection when the WLAN network connection is no longer available resulting in increased battery life when not connected.

Antenna Diversity

Intel PRO/Wireless 2100 network connection always selects the best antenna based on the best signal-to-noise ratio (not signal strength) on a packet-by-packet basis. This mitigates multi-path problems and results in increased usable range and throughput.

Intel® Centrino™ Mobile Technology Product Features Summary

Intel® Pentium® M Processor

- Supports Intel Pentium M Micro -Architecture
 - Micro-Ops Fusion
 - Advanced Instruction Prediction
 - Dedicated Stack Manager
 - Power-Optimized 400 MHz Processor System Bus
 - Intelligent Power Distribution
 - On-die, Power-Aware 1MB Secondary Cache
 - Deeper Sleep State
- Supports Enhanced Intel® SpeedStep™ Technology with Multiple Voltage / Frequency Operating Points
- 0.13 micron Process Technology
- On-die primary 32KB (L1) instruction and data
- Integrated math co-processor
- Micro-FCPGA and Micro-FCBGA packaging technology
- Exposed die enables more efficient heat dissipation
- Fully compatible with previous Intel microprocessors
- Binary compatible with all applications
- Support for MMX™ technology
- Support for Streaming SIMD Extensions 2
- Power Management Features
- Deep Sleep and Deeper Sleep modes provide low power dissipation
- On-die thermal diode

Intel® 855 Chipset Family

- Intel® 855PM AGP 4X interface provides flexible support for high performance discrete graphics solutions.
- Optional Intel® 855GM chipset provides integrated graphics solution w/ Intel® Extreme Graphics 2
- Intel 855GM integrated low voltage differential signal (LVDS) interface
- Dynamic input/output buffer disabling for processor system bus & memory
- Optimized Internal Clock Gating for 3D and Display Engines with Intel 855GM
- Intel® Stable Image Technology
- DDR Memory 266 / 200MHz
- Up to 2GB DDR Memory Support
- I/O Controller Hub Architecture with USB 2.0 Support
- Integrated 10/100 LAN, Enhanced 20-bit Audio, and AC97 Modem (56kbps) Interface
- ACPI 2.0 and APM 1.2 system power management
- Mobile Clock Manager
- PCI Moon2 Docking Support

Intel® PRO/Wireless 2100 Network Connection

- Single and dual band WLAN support 802.11b & 802.11a/b
- Supporting industry standard and extended wireless security support (LEAP, WPA, 802.1x, WEP)
- Intel® PROSet Software with advanced profile management support
- Intel PROSet with automatic WLAN switching support
- IntelPROSet with ad hoc connection wizard support
- Intel Wireless Coexistence System support
- Power Save Protocol (PSP)
- IntelIntelligent Scanning Technology
- Antenna diversity

Wireless connectivity and some features may require you to purchase additional software, services or external hardware. Availability of public wireless LAN access points limited. System performance measured by MobileMark 2002. System performance, battery life, wireless performance and functionality will vary depending on your specific hardware and software configurations. See http://www.intel.com/products/centrino/more_info for more information.* Other trademarks and brands are the property of their respective owners.